

JOHNSTON ATOLL OCEAN SCIENCE STUDY

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LONG-TERM GOALS

The "Johnston Atoll Ocean Science Study" is a long-term marine biological investigation of an isolated tropical reef ecosystem in the North Central Pacific Ocean. The scientific research program is a required component of the Department of Defense mission at Johnston Atoll. This work is supported primarily by the U.S. Army Program Manager for Chemical Demilitarization, U.S. Air Force Pacific Command, and the Defense Special Weapons Agency. This study provides environmental and oceanographic analyses which are important considerations in environmental assessment, natural resources management and military operation plans. The research program includes time-series measurement (i.e. monitoring) of key indicator species and selected physical environmental variables. Monitoring includes measurements for determining natural physical environmental cycles and coincident fluctuations in fishes and other reef animal populations and the spawning patterns of selected indicator species. The research aims to distinguish between anthropogenic affects versus natural variability of the marine ecosystem when evaluating changes in the abundance and distribution of key indicator species.

OBJECTIVES

The objective is to understand the natural physical and biological processes affecting the biota of this isolated atoll. This objective is fundamental to evaluating possible adverse environmental impacts caused by pollution or disturbances from military activities on Johnston Island. The purpose of this program is to provide the scientific database which can be applied to issues of environmental impact and natural resources management for this Department of Defense installation. This work supported by ONR Biological Oceanography.

APPROACH

A novel aspect of this project is the development of a passive acoustic method to quantify fish reproductive activity. This method can provide a sensitive measure

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of pollution impacts, if any, on the biota. Specific sounds have been associated with the courtship and mating activities of some fishes (Lobel 1992, 1996; Lobel and Mann 1995) and acoustic technology was developed that provides an automatic method for counting fish spawning sounds through time (Mann and Lobel 1995). Alteration or cessation of fish reproduction is an early warning sign of pollution impacts. The project also includes a comprehensive assessment of the concentration and distribution of contaminants in lagoon sediments and in selected biota. In addition, We developed the first underwater plutonium detector to survey fallout from the aborted nuclear rocket tests in the 1960's. Thus, the approach of this project is to 1. define the nature and extent of military-industrial contamination throughout the atoll ecosystem, 2. Map the distribution and abundance of reef organisms across the atoll through time, and 3. to determine the spawning and recruitment patterns of fishes in relationship to physical oceanographic variables.

WORK COMPLETED:

1. Completed atoll-wide sediment sampling and analysis for contaminants (Lobel et al 1997).
2. Completed biota sampling and analysis for contaminants at selected sites (Lobel et al 1997, Kerr 1997, Kerr et al 1997).
3. Designed, built and successfully field tested an underwater towed radiation detector (Johnson et al 1997).
4. Determined that metal artificial reef corrosion can kill fish embryos in damselfish nests laid on the artificial reef's surface(Kerr 1996).
5. Developed new technology and successfully tested the "spawn-o-meter", a passive acoustic detection system.
6. Recorded and described sound patterns produced by spawning fishes (Lobel 1996, Mann & Lobel 1997a,b).
7. Continued counts of fish abundance's, spawning cycles and recruitment patterns (Lobel 1997, Economakis & Lobel 1997, Sancho et al 1997).
8. Initiated a study of coral growth rates and bleaching using staining of live colonies and isotopic analysis of specimens (Cohen et al 1997).
9. Completed writing for DoD " Coral Reef Conservation Guide for the Military" (Lobel 1997).

RESULTS

It is too early in the overall research program to make final conclusions about the potential environmental impact of contaminants from military activities. We have successfully demonstrated the utility and efficiency of our methodological approaches and devices. We have demonstrated that some fish produce specific spawning sounds that can be easily monitored acoustically. We have mapped the pattern of contaminant concentrations throughout the lagoon and determined

uptake in a few selected key indicator species. We developed an underwater radiation detector to map fallout. Other results are detailed in our publications.

IMPACT

To date, there are three major impacts/applications for science and society from the results of this research program. Firstly, The development of the passive acoustic detection system for quantifying spawning cycles in those fish species producing sounds offers a new non-destructive sampling technique for time-series measurement of spawning species simultaneously with measurements from physical oceanographic instrumentation. This has important implications for fisheries management and national science projects like GLOBEC. Secondly, We have been working closely with the Environmental Protection Agency, Region 9 in applying our experience and results to establishing a basis for regulatory guidelines for assessing the effects of contaminants on coral reef ecosystems. We have also used our experience to write “ Coral Reef Conservation Guide for the Military” for DoD Office of Environmental Security. Thirdly, we have a fully operational underwater radiation detector that can measure fallout from nuclear tests. At a meeting on Johnston Atoll last year led by Ms. Sheri Goodman, the visiting Russian military officers expressed interest in this device for work in Russia.

TRANSITIONS

I wrote for DoD the “ Coral Reef Conservation Guide for the Military” based largely on the experience from this project.

The acoustic studies of fishes has spawned new hydrophones, electric field of fish detectors and recording technology, now being marketed by the company BioAcoustics Inc.

RELATED PROJECTS

Wake Atoll. I was funded by the DoD Legacy Resource Management program to conduct an underwater survey, produce an inventory of reef fishes and to assess the potential environmental problems on Wake Atoll, Marshall Islands in support of continued DoD missions.

I was also funded by the DoD Legacy Resource Management program to write a “ Coral Reef Conservation Guide for the Military” based mostly upon the Johnston Atoll experience.

My postdoc, Anne Cohen was funded by NSF (award K-100040) in a proposal she co-authored with Stan Hart, WHOI. Their proposal included work on Johnston

Atoll and is titled “ High resolution calibration and validation of proxy records in corals”.

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